5.0 ENVIRONMENTAL BASELINE

The purpose of this section is to identify "the past and present effects of all Federal, State, or private activities in the action area, the anticipated effects of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the effect of State or private actions which are contemporaneous with the consultation in process" (50 CFR § 402.02, definition of "effects of the action"). These factors affect the species' environment or critical habitat in the action area. The factors are described in relation to the action area biological requirements of the species.

5.1 DESCRIPTION OF ACTION AREA

The action area relative to both juvenile and adult Columbia basin salmonids is the part of their habitat that is affected by the FCRPS and other BOR project operations, as described in Section 1. The area is best defined as the farthest upstream point at which smolts enter (or adults exit) the Snake and upper Columbia rivers to the farthest downstream point at which they exit (or adults enter) the migration corridor. In the Snake River, the area translates to immediately below Hells Canyon Dam (or wherever a tributary stream meets the Snake River below Hells Canyon Dam) to the confluence of the Snake and Columbia rivers. In the Columbia River, the action area begins immediately below Chief Joseph Dam (or wherever a tributary stream meets the Columbia River below Chief Joseph Dam). Although the actual upstream extent of the action area varies among ESUs, in all cases the action area extends downstream to the farthest point (the Columbia River estuary and nearshore ocean environment) at which listed salmonids are influenced by FCRPS water management.

5.2 BIOLOGICAL REQUIREMENTS IN ACTION AREA

To some degree, each of the 12 ESUs considered in this opinion reside in, or migrate through, the action area. Biological requirements during these life history stages are obtained through access to essential features of critical habitat. Essential features include adequate 1) substrate (especially spawning gravel), 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) migration conditions (58 FR 68546 for Snake River salmon and 65 FR 773 for all other Columbia River basin salmonids).

5.2.1 Essential Features of Critical Habitat in Action Area

The sections below describe essential features of critical habitat for each of the relevant habitat types: 1) juvenile rearing areas, 2) juvenile migration corridors, 3) areas for growth and development to adulthood, 4) adult migration corridors, and 5) spawning areas in the action area discussed in the following sections.

5.2.1.1 Juvenile Rearing Areas

Essential features of critical habitat for juvenile rearing areas include adequate water quality, water quantity, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. The requirement for adequate substrate, although relevant to incubation of redds in the mainstem, is discussed under spawning areas, below.

5.2.1.2 Juvenile Migration Corridors

Essential features of critical habitat for juvenile migration corridors include adequate water quality, water quantity, water velocity, cover/shelter, food, riparian vegetation, space, and migration conditions.

5.2.1.3 Areas for Growth and Development to Adulthood

Essential features of critical habitat for areas for growth and development to adulthood include all the essential features of critical habitat for juvenile rearing areas (above).

5.2.1.4 Adult Migration Corridors

Essential features of critical habitat for adult migration corridors include all the essential features of critical habitat for juvenile migration corridors (above), except for adequate food.

5.2.1.5 Spawning Areas

Essential features of critical habitat for spawning areas include all the essential features of critical habitat for juvenile rearing areas (above), with the addition of adequate substrate and the exception of adequate food.

5.2.2 Adequacy of Habitat Conditions in Critical Habitat

Regulations implementing Section 7(a)(2) of the ESA define "destruction or adverse modification" as "a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species." Adverse effects on a constituent element of critical habitat generally do not result in a determination of "adverse modification" unless that loss, when added to the environmental baseline, is likely to result in an appreciable decline in the value of the critical habitat for both the survival and the recovery of the listed species (50 CFR Section 402.02).

Quantitatively defining a level of adequacy through specific, measurable standards is difficult for many of these biological requirements. In many cases, the absolute relationship between the critical element and species survival is not clearly understood, thus limiting development of specific, measurable standards. Some parameters are generally well known in the fisheries literature (e.g., thermal tolerances), allowing NMFS to develop a performance standard in this biological opinion (e.g., a temperature objective at Lower Granite Dam). For other action-area biological requirements, the effects of any adverse impacts on essential features of critical habitat are considered in more qualitative terms.

5.3 FACTORS AFFECTING SPECIES' ENVIRONMENT IN ACTION AREA

5.3.1 Hydrosystem Effects

Columbia River basin anadromous salmonids, especially those above Bonneville Dam, have been dramatically affected by the development and operation of the FCRPS. Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph of the Snake and Columbia rivers, decreasing spring and summer flows and increasing fall and winter flows. Power operations cause flow levels and river elevations to fluctuate, affecting fish movement through reservoirs and riparian ecology, and stranding fish in shallow areas. The eight dams in the migration corridor of the Snake and Columbia rivers alter smolt and adult migrations. Smolts experience a high level of mortality passing through the dams. The dams also have converted the once-swift river into a series of slow-moving reservoirs, slowing the smolts' journey to the ocean and creating habitat for predators. Water velocities throughout the migration corridor now depend far more on volume runoff than before development of the mainstem reservoirs.

There have been numerous changes in the operation and configuration of the FCRPS as a result of ESA consultations between the Action Agencies (BPA, the Corps, and BOR) and the services (NMFS and USFWS). The changes have improved survival for the listed fish migrating through the Snake and Columbia rivers. Increased spill at all FCRPS dams allows smolts to avoid both turbine intakes and bypass systems. Increased flow in the mainstem Snake and Columbia rivers provides better inriver conditions for smolts. The transportation of smolts from the Snake River has also been improved by the addition of new barges and modification of existing barges.

In addition to spill, flow, and transportation improvements, the Corps implemented numerous other improvements to project operations and maintenance at all Columbia and Snake river dams. These improvements, such as operating turbines at peak efficiency, new extended-length screens at McNary, Little Goose, and Lower Granite dams, and extended operation of bypass screens, are discussed in greater detail in the 1995 FCRPS Biological Opinion.

It is possible to quantify the survival benefits accruing from these many actions for each of the listed ESUs. For SR spring/summer chinook smolts migrating inriver, the estimated direct survival through the hydrosystem is now between 40% and 60%, compared with an estimated survival rate during the 1970s of 5% to 40%. SR steelhead have probably received a similar benefit because their life history and run timing are similar to those of spring/summer chinook (NMFS 2000h). It is more difficult to obtain direct data and compare survival improvements for fish transported from the Snake River, but there are likely to be improvements for transported fish as well. It is reasonable to expect that the improvements in operation and configuration of the FCRPS will benefit all listed Columbia basin salmonids and that the benefits will be greater the farther upriver the ESU. However, further improvements are necessary because the Federal hydrosystem continues to cause a significant level of mortality for some ESUs.

Several non-Federal projects licensed by the Federal Energy Regulating Commission (FERC) also affect the 12 ESUs on the mainstem Columbia and Snake rivers. Many of the ESUs are also affected by FERC projects on smaller tributaries or other water development projects.

5.3.2 Habitat Effects

The quality and quantity of freshwater habitat in much of the Columbia River basin have declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydrosystem development, mining, and urbanization have radically changed the historical habitat conditions of the basin. With the exception of fall chinook, which generally spawn and rear in the mainstem, salmon and steelhead spawning and rearing habitat is found in tributaries to the Columbia and Snake rivers. Anadromous fish typically spend from a few months to 3 years rearing in freshwater tributaries. Depending on the species, they spend from a few days to 1 or 2 years in the Columbia River estuary before migrating out to the ocean and another 1 to 4 years in the ocean before returning as adults to spawn in their natal streams. Thirty-two subbasins provide spawning and rearing habitat.

Water quality in streams throughout the Columbia River basin has been degraded by human activities such as dams and diversion structures, water withdrawals, farming and grazing, road construction, timber harvest activities, mining activities, and urbanization. Over 2,500 streams and river segments and lakes do not meet Federally approved, state and Tribal water quality standards and are now listed as water-quality-limited under Section 303(d) of the CWA. Tributary water quality problems contribute to poor water quality where sediment and contaminants from the tributaries settle in mainstem reaches and the estuary.

Most of the water bodies in Oregon, Washington, and Idaho that are on the 303(d) list do not meet water quality standards for temperature. Temperature alterations affect salmonid metabolism, growth rate, and disease resistance, as well as the timing of adult migrations, fry emergence, and smoltification. Many factors can cause high stream temperatures, but they are primarily related to land-use practices rather than point-source discharges. Some common actions that result in high stream temperatures are the removal of trees or shrubs that directly shade streams, excessive water withdrawals for irrigation or other purposes, and warm irrigation return flows. Loss of wetlands and increases in groundwater withdrawals have contributed to lower base-stream flows, which in turn contribute to temperature increases. Channel widening and land uses that create shallower streams also cause temperature increases.

Pollutants also degrade water quality. Salmon require clean gravel for successful spawning, egg incubation, and emergence of fry. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs. Excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect the water quality for salmon and steelhead.

Water quantity problems are also a significant cause of habitat degradation and reduced fish production. Millions of acres of land in the basin are irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, urban, and other uses can increase temperatures, smolt travel time, and sedimentation. Return water from irrigated fields can introduce nutrients and pesticides into streams and rivers.

On a larger landscape scale, human activities have affected the timing and amount of peak water runoff from rain and snowmelt. Forest and range management practices have changed vegetation types and density, which can affect timing and duration of runoff. Many riparian areas, flood plains, and wetlands that once stored water during periods of high runoff have been developed. Urbanization paves over or compacts soil and increases the amount and pattern of runoff reaching rivers and streams.

Many tributaries have been significantly depleted by water diversions. In 1993, fish and wildlife agency, Tribal, and conservation group experts estimated that 80% of 153 Oregon tributaries had low-flow problems (two-thirds caused at least in part by irrigation withdrawals) (OWRD 1993). The NWPPC showed similar problems in many Idaho, Oregon, and Washington tributaries (NWPPC 1992).

Blockages that stop the downstream and upstream movement of fish exist at many agricultural, hydrosystem, municipal/industrial, and flood control dams and barriers. Highway culverts that are not designed for fish passage also block upstream migration. Migrating fish are diverted into unscreened or inadequately screened water conveyances or turbines, resulting in unnecessary mortality. While many fish-passage improvements have been made in recent years, manmade structures continue to block migrations or kill fish throughout the basin.

Land ownership has played a part in habitat and land-use changes. Federal lands, which compose 50% of the basin, are generally forested and influence upstream portions of the watersheds. While there is substantial habitat degradation across all ownerships, in general, habitat in many headwater stream sections is in better condition than in the largely non-Federal lower portions of tributaries (Doppelt et al. 1993, Frissell 1993, Henjum et al. 1994, Quigley and Arbelbide 1997). In the past, valley bottoms were among the most productive fish habitats in the basin (Stanford and Ward 1992, Spence et al. 1996, ISG 1996). Today, agricultural and urban land development and water withdrawals have significantly altered the habitat for fish and wildlife. Streams in these areas typically have high water temperatures, sedimentation problems, low flows, simplified stream channels, and reduced riparian vegetation.

Mainstem habitats of the Columbia, Snake, and Willamette rivers have been affected by impoundments that have inundated large amounts of spawning and rearing habitat. Historically, fall chinook salmon spawned in the mainstem near The Dalles, Oregon, upstream to the Pend Oreille River in Washington and the Kootenai River in Idaho, in the Snake River downstream of Shoshone Falls, and upstream from the mouth of the Snake River to Grand Coulee Dam. Current mainstem production areas for fall chinook are mostly confined to the Hanford Reach of the mid-Columbia River and to the Hells Canyon Reach of the Snake River, with minor spawning populations elsewhere in the mid-Columbia, below the lower Snake River dams, and below Bonneville Dam. Hanford Reach is the only known mainstem spawning area for steelhead. Chum salmon habitat in the lower Columbia may also have been inundated by Bonneville Reservoir. Mainstem habitat in the Columbia, Snake, and Willamette rivers has been reduced, for the most part, to a single channel, floodplains have been reduced in size, off-channel habitat features have been lost or disconnected from the main channel, and the amount of large woody debris (large snags/log structures) in rivers has been reduced. Most of the remaining habitats are affected by flow fluctuations associated with reservoir management.

The Columbia River estuary has also been changed by human activities. Historically, the downstream half of the estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. The mouth of the Columbia River was about 4 miles wide. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River kept the environment dynamic. Today, navigation channels have been dredged, deepened and maintained, jetties and pile-dike fields have been constructed to stabilize and concentrate flow in navigation channels, marsh and riparian habitats have been filled and diked, and causeways have been constructed across waterways. These actions have decreased the width of the mouth of the Columbia River to 2 miles and increased the depth of the Columbia River channel at the bar from less than 20 to more than 55 feet. Sand deposition at river mouths has extended the Oregon coastline approximately 4 miles seaward and the Washington coastline approximately 2 miles seaward (Thomas 1981).

More than 50% of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted to other uses since 1948 (Lower Columbia River Estuary Program [LCREP] 1999). Many wetlands along the shore in the upper reaches of the estuary have been converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from reservoirs upstream of the estuary have changed the seasonal pattern and volume of discharge. The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased.

Studies begun in 1997 by the Oregon Cooperative Fish and Wildlife Research Unit, USGS, and CRITFC have shown that fish-eating birds that nest on islands in the Columbia River estuary (Caspian terns, double-crested cormorants, and glaucous-winged gulls) are significant avian predators of juvenile salmonids. Researchers estimated that the tern population on Rice Island (16,000 birds in 1997) consumed 6 to 25 million outmigrating smolts during 1997 (Roby et al. 1998) and 7 to 15 million outmigrating smolts during 1998 (Collis et al. 1999). The observed levels of predation prompted the regional fish and wildlife managers to investigate the feasibility of management actions to reduce the impacts. Early management actions appear to have reduced predation rates; researchers estimate that terns consumed 7.3 million smolts during 1999 (Columbia Bird Research 2000). Because Rice Island is a dredged material disposal site in the Columbia River estuary, created by the Corps under its Columbia River Channel Operation and Maintenance Program, the effects of tern predation on the survival and recovery of listed salmonids are considered in a separate consultation on that program. This factor is considered part of the environmental baseline on effects of the FCRPS.

The Basinwide Recovery Strategy outlines a broad range of current habitat programs. Because most of the basin's anadromous fish spawning habitat is in Federal ownership, Federal land management programs are of primary importance. Current management is governed by an ecosystem-based aquatic habitat and riparian-area management strategy known as PACFISH and associated biological opinions. This interim strategy covers the majority of the basin accessible to anadromous fish and includes specific prescriptions designed to halt habitat degradation.

The Basinwide Recovery Strategy also outlines a large number of non-Federal habitat programs. Because non-Federal habitat is managed predominantly for private rather than public purposes, however, expectations for non-Federal habitat are harder to assess. Degradation of habitat for listed fish from activities on non-Federal lands is likely to continue to some degree over the next 10 years, although at a reduced rate due to state, Tribal, and local recovery plans.

5.3.3 Hatchery Effects

For more than 100 years, hatcheries in the Pacific Northwest have been used to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. As a result, most salmon populations in this region are primarily hatchery fish. In 1987, for example, 95% of the coho, 70% of the spring chinook, 80% of the summer chinook, 50% of the fall chinook, and 70% of the steelhead returning to the Columbia basin originated in hatcheries (CBFWA 1990).

While hatcheries certainly have contributed greatly to the overall numbers of salmon, only recently has the effect of hatcheries on native wild populations been demonstrated. In many cases, these effects have been substantial. For example, production of hatchery fish, among other factors, has contributed to the 90% reduction in wild coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995). Hatcheries have traditionally focused on providing fish for harvest, with less attention given to identifying and resolving factors causing declines of native runs.

NMFS has identified four primary categories of risk that hatcheries can pose on wild-run salmon and steelhead: 1) ecological effects, 2) genetic effects, 3) overharvest effects, and 4) masking effects (NMFS 2000g). Ecologically, hatchery fish can increase predation on, displace, and/or compete with wild fish. These effects are likely to occur when fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods during which they may prey on or compete with wild fish. Hatchery fish also may transmit hatchery-borne diseases, and hatcheries themselves may release diseases into streams via water effluents.

Genetically, hatchery fish can affect the genetic variability of native fish via interbreeding, either intentionally or accidentally. Interbreeding can also result from the introduction of native stocks from other areas. Theoretically, interbred fish are less adapted to and productive within the unique local habitats where the original native stock evolved.

In many areas, hatchery fish provide increased fishery opportunities. When wild fish mix with hatchery stock, fishing pressure can lead to overharvest of smaller or weaker wild stocks. Further, when migrating adult hatchery and wild fish mix on the spawning grounds, the health of the wild runs and the condition of the habitat's ability to support runs can be overestimated, because the hatchery fish mask surveyors' ability to discern actual wild run conditions.

The role of hatcheries in the future of Pacific Northwest salmon and steelhead is presently unclear; it will depend on the values people place on fish production and biological diversity. Clearly, conservation of biological diversity is gaining support, and the future role of hatcheries may shift toward judicial use of hatcheries to meet these goals rather than opposing them. One of the prime recommendations in the National Research Council's (NRC's) study of salmon in the Pacific Northwest is that hatchery use "should occur within the context of fully implemented adaptive-management programs that focus on watershed management, not just on the fish themselves" (NRC, 1996). A recent review of this approach for the Columbia basin can be found in ISAB (1998).

5.3.4 Harvest Effects

The history of harvest of Columbia River basin salmon parallels that of the entire region. Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800s. Development of non-Indian fisheries began in about 1830; by 1861, commercial fishing was an important economic activity. The early commercial fishery used gill nets, seines hauled from shore, traps, and fish wheels. Later, purse seines and trolling (using hook and line) fisheries developed. Recreational (sport fishing) began in the late 1800s, occurring primarily in tributary locations (ODFW and WDFW 1998).

Initially, the non-Indian fisheries targeted spring and summer chinook salmon, and these runs dominated the commercial harvest during the 1800s. Eventually the combined ocean and freshwater harvest rates for Columbia River spring and summer chinook exceeded 80% and sometimes 90% of the run, contributing to the species' decline (Ricker 1959). From 1938 to 1955, the average harvest rate dropped to about 60% of the total spring chinook salmon run and appeared to have a minimal effect on subsequent returns (NMFS 1991b). Until the spring of 2000, when a relatively large run of hatchery spring chinook returned and provided a small commercial Tribal fishery, the last commercial season for spring chinook had occurred in 1977. Present Columbia River harvest rates are very low compared with those from the late 1930s through the 1960s (NMFS 1991b).

The summer chinook salmon run could not sustain the average harvest rate of 88% that was applied between 1938 to 1944 and produced lower returns between 1942 and 1949 (NMFS 1991b). From 1945 through 1949, the Columbia River harvest rate on summer chinook salmon was reduced to about 47%, and subsequently, the run size increased. Construction of Grand Coulee Dam in 1941, with the resulting inundation of summer chinook spawning areas, was a primary factor influencing this species' declining abundance. In the 1950s and 1960s, harvest rates further declined to about 20% (Raymond 1988). This species has not been the target of any commercial harvest since 1963.

Following the sharp declines in spring and summer chinook in the late 1800s, fall chinook salmon became a more important component of the catch. Fall chinook have provided the greatest contribution to Columbia River salmon catches in most years since 1890. Through the first part of this century, the commercial catch was usually canned for marketing. The peak year of commercial sales was 1911, when 49.5 million pounds of fall chinook were landed. Columbia River chinook salmon catches were generally stable from the beginning of commercial exploitation until the late 1940s, when landings declined by about two-thirds to a level that remained stable from the 1950s through the mid-1980s (ODFW and WDFW 1998). Since 1938, total salmonid landings (all species) have ranged from a high of about 2,112,500 fish in 1941 to a low of about 68,000 fish in 1995 (Figure A.1 in ODFW and WDFW 1998).

Whereas freshwater fisheries in the basin were declining during the first half of this century, ocean fisheries were growing, particularly after World War II. This trend occurred up and down the West Coast as fisheries with new gear types leapfrogged over the others to gain first access to the migrating salmon runs. Large, mixed-stock fisheries in the ocean gradually supplanted the freshwater fisheries, which were increasingly restricted or eliminated to protect spawning escapements. By 1949, the only freshwater commercial gear types remaining were gill nets, dip nets, and hoop nets (ODFW and WDFW 1998). This leapfrogging by various fisheries and gear types resulted in conflicts about harvest allocation and the displacement of one fishery by another. Ocean trolling peaked in the 1950s; recreational fishing peaked in the 1970s. The ocean harvest has declined since the early 1980s as a result of declining fish populations and increased harvest restrictions (ODFW and WDFW 1998).

The construction of The Dalles Dam in 1957 had a major effect on Tribal fisheries. The Dalles Reservoir flooded Celilo Falls and inundated the site of a major Indian fishery that had existed for millennia. Commercial Indian landings at Celilo Falls from 1938 through 1956 ranged from

0.8 to 3.5 million pounds annually, based primarily on dip netting (ODFW and WDFW 1998). With the elimination of Celilo Falls, salmon harvest in the area declined dramatically. In 1957, in a joint action, the states of Oregon and Washington closed the Tribal fishery above Bonneville Dam to commercial harvesters. Treaty Indian fisheries that continued during 1957 through 1968 were conducted under Tribal ordinances. In 1968, with the Supreme Court opinion on the appeal of the *Puyallup v. Washington* case, the states reopened the area to commercial fishing by treaty Indians (ODFW and WDFW 1998). For the next 6 years, until 1974, only a limited Tribal harvest occurred above Bonneville Dam. By then, the Tribal fishery had developed an alternative method of setting gill nets that was suitable for catching salmon in the reservoirs (ODFW and WDFW 1998).

The capacity of salmonids to produce more adults than are needed for spawning offers the potential for sustainable harvest of naturally produced (versus hatchery-produced) fish. This potential can be realized only if two basic management requirements are met: 1) enough adults return to spawn and perpetuate the run, and 2) the productive capacity of the habitat is maintained. Catches may fluctuate in response to such variables as ocean productivity cycles, periods of drought, and natural disturbance events. However, as long as the two management requirements are met, fishing can be sustained indefinitely. Unfortunately, both prerequisites for sustainable harvest have been violated routinely in the past. The lack of coordinated management across jurisdictions, combined with competitive economic pressures to increase catches or to sustain them in periods of lower production, resulted in harvests that were too high and escapements that were too low. At the same time, habitat has been increasingly degraded, reducing the capacity of the salmon stocks to produce numbers in excess of their spawning escapement requirements.

For years, the response to declining catches was hatchery construction to produce more fish. Because hatcheries require fewer adults to sustain their production, harvest rates in the fisheries were allowed to remain high, or even increase, further exacerbating the effects of overfishing on the naturally produced (nonhatchery) runs mixed in the same fisheries. More recently, harvest managers have instituted reforms including weak stock, abundance-based, harvest rate, and escapement-goal management.

5.3.5 Natural Conditions

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. For example, large-scale climatic regimes, such as El Niño, affect changes in ocean productivity. Much of the Pacific Coast was subject to a series of very dry years during the first part of the 1990s. In more recent years, severe flooding has adversely affected some stocks. For example, the low return of Lewis River bright fall chinook salmon in 1999 is attributed to flood events during 1995 and 1996.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although the levels of predation are largely unknown. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations, following their protection under the Marine Mammal Protection Act of 1972, has resulted in substantial mortality for salmonids. In recent years, for example, sea lions have learned to target UWR spring chinook salmon in the fish ladder at Willamette Falls.

A key factor substantially affecting many West Coast stocks has been the general pattern of a 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood. The pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries of subadults relative to the number of CWTs released from that brood year. Time-series of survival rate information for UWR spring chinook, Lewis River fall chinook, and Skagit fall chinook salmon show highly variable or declining trends in early ocean survival, with very low survival rates in recent years (NMFS 1999c).

Recent evidence suggests that marine survival of salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Cramer et al. 1999). This phenomenon has been referred to as the Pacific Decadal Oscillation (PDO). Ocean conditions that affect the productivity of Northwest salmonid populations appear to have been in a low phase of the cycle for some time and to have been an important contributor to the decline of many stocks. The survival and recovery of these species will depend on their ability to persist through periods of low natural survival.

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